Perceptions of Building-layout Complexity

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Abstract. This poster presents an experiment on judgments of design complexity, based on two modes of stimuli: the layouts of corridor systems in buildings shown in plan view and movies of simulated walkthroughs. Randomly selected stimuli were presented to 166 subjects: 'experts' (architects or students currently enrolled on an architectural course) and 'lay people' (all others). The aims were to investigate whether there were differences between these two groups in terms of their judgments of building complexity, effects of modality of stimuli and if any environmental measures (geometric or complexity-based) correlated with the assessments. The results were, first, there are differences between the judgments of the experts and non-experts, second, the effect of modality was negligible for lay people but evident for the 'experts', third, the judgments of both groups correlated highly with a number of environmental measures.

Keywords: navigation, wayfinding, complexity

1 Aims and Significance

Three aims support the experiment presented in this poster. First is the investigation of the differences in how architects and non-architects view building-layout designs with respect to perceptions of complexity and judged ease of wayfinding. Second is to determine whether the mode of presentation of the design influences such judgment. Third is to determine whether the subject's judgements of design complexity correlate with a set of objective, environmental measures.

This study focuses on two particular types of design-criterion that *may* play a role in the process of architectural design, that of 'design complexity' and the allied judgment of 'ease of wayfinding'. These judgements are of importance, not only to the architect engaged in the process of design, but equally to the end-user of any building. Previous work on judgments of complexity has tended to fall predominantly into one of two groups: those primarily concerned with subjective assessments of design and those focused on computational measures of complexity. This poster attempts to consider *both* the subjective assessments of complexity as well as objective, computational measures and to determine the relationship between them.

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2 Method

The study by Weisman [4] provided the first systematic assessment of floor plan complexity by human judges. He used thirty simplified building layouts that spanned a wide variety of building styles. We opted to use his original materials as the starting point for this study.

Thirty simplified building layouts were used. Our stimuli, both in plan and movie mode, are reduced to corridors, with no indication of the building-envelope, rooms or other spatial subdivisions. The corridor-layouts were then assigned to a number of classes or 'bins' from which stimuli could be selected randomly. The layouts were grouped into the bins by attributes of their environmental features. Having established 16 bins based on the number of axial lines, the number of spatial symmetries and O'Neil's ICD measure [3], it became evident that two additional building layouts were required. These were added to the sample, ensuring that each bin contained between 1 and 3 layouts.

The construction of each walkthrough movie required the selection of navigational paths for each building layout. The paths aimed to traverse the maximally possible distance. This difference between the modalities means that the task for the judge is quite a different one for the plan views versus the egocentric movies (see fig.1 for example stimuli).

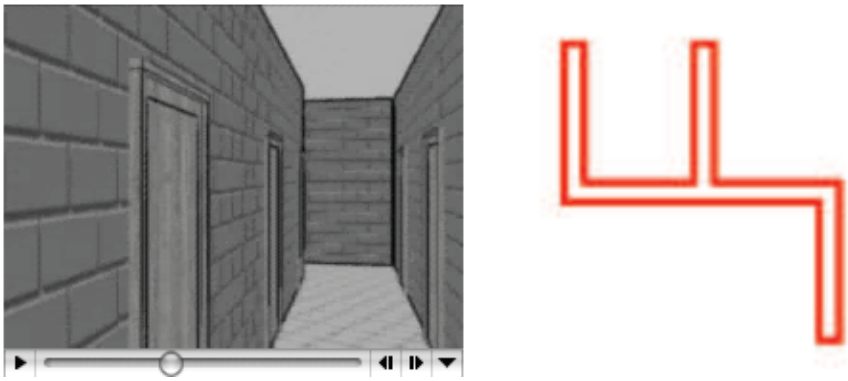

Fig1. Layout-stimuli as Ego-centric Movie (left) & Abstracted Plan (right)

The complexity-judging task was administered in the form of an online questionnaire, which took approximately 20-30 minutes to complete. Each participant is presented with 16 layouts, one from each bin. Each layout is presented both as a movie and as a plan view. Presentation format and order is balanced and randomized into six blocks of 5-6 stimuli, with each block containing either movies or plans.

Subjects were instructed to view each plan or movie and were asked to make two judgments: first, of the complexity of the layout (ranging from 'simple' to 'complex') and second, of the projected ease or difficulty of finding one's way around a building

with such a plan configuration (ranked between 'easy' and 'difficult'). Both ratings used 9-point, discrete Likert-scales. In total 166 subjects successfully completed all parts of the questionnaire and were included in the following analyses. Of these 52 were architects or had an architectural education and 114 could be considered 'non-experts' or laypersons.

A number of measures were calculated to determine if any objective factors of the built environment correlated with people's subjective judgements of complexity and could thus be used predictively. Many of these were straightforward geometric measures such as a layout's area, perimeter or its number of walls and polygon vertices. Other measures were included due to evidence in the wayfinding literature that they may play a role in how easily people navigate: the number of symmetries was included (the number of lines of symmetry, rotational symmetries and their sum were evaluated) and the number of axial lines and convex spaces [2] in the layout. Finally, other measures were calculated: the number of 'topological holes' in a layout, convexity (a measure developed by Batty [1])) and O'Neill's measure of 'ICD' [3] or *interconnection density.*

3 Results

In this study we find substantial differences between the measures of 'complexity' and 'wayfinding' when comparing movies versus plans or experts versus laypeople.

The results of this study reveal that the laypeople's ratings of complexity versus wayfinding differed more distinctly when rating movies, and with smaller differences in rating plan-view images. This can be contrasted to the performance of the experts who appear to perceive greater differences between complexity and wayfinding difficulty in plans rather than movies. Architectural experts judge the same materials as being simpler in plan mode, while laypeople judge the layouts as simpler when presented as movies. A tentative interpretation of this finding is that experts are more familiar with assessing plan views, while laypeople have greater difficulties interpreting plans and thus find movies easier to comprehend. This difference does not extend to rating wayfinding difficulties per se: a further indicator that architects and laypeople interpret the two rating tasks in a different manner.

4 Correlation between Judgments and Environmental Factors

A number of environmental variables are shown to correlate highly with participants' judgments. Architects react differently to symmetry depending on the presentation modality; they appear to be distinctly critical of the complete lack of symmetry in the low-symmetry group when presented in movie-mode. In plan-view, the high-symmetry, high-number-of-elements stimuli are judged as rather complex and difficult to navigate, while in movie-mode these elements receive relatively positive ratings. For complexity, the pattern is similar: highly symmetric elements are judged as simple and easily navigable in the movie modality, but in plans, the experts attribute high complexity to layouts with many elements, despite high symmetry. In

conclusion, the fact that the variables initially identified through factor analysis appear to be particularly relevant for predicting human assessments of complexity and navigability can be taken as an indication that our stimuli covered a considerable range of the potential feature space.

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